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Alternate Processes for In-service Welding
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Conducting weld deposition repairs and attaching hot-tapping sleeves to in-service pipelines has the incentive of avoiding loss of service and revenues. However, welding procedures must be applied with precise control of many variables to avoid burn-through and hydrogen induced cold cracking. Recently, procedures have been investigated and developed for the application of Shielded Metal Arc Welding to in-service pipeline repair, however the consistency of welding cannot be easily controlled with this process due to its manual application. Therefore, processes need to be investigated that can be applied with mechanized travel and torch control to minimize the variability in applying repair procedures. The Gas Metal Arc Welding and Self Shielded Flux Cored Arc Welding processes are wire fed processes that have the advantage and ability to be applied with mechanized travel and torch control, and are therefore the focus of this study.

The tasks involved in developing welding procedures for in-service pipeline repair with the aforementioned processes are:

1. Review the literature from industry and available pipeline research reports, and summarize the elements of currently recommended procedures for welding on in-service pipelines. Select pipe grades and welding electrodes for investigation.
2. Establish practical welding parameter ranges for buttering and fillet welds with each process / electrode combination.
3. Examine the critical thickness for burn-through to occur with each process.
4. Characterize the 800 to 500ºC cooling rate time's vs heat input and arc efficiency of each process. Evaluate productivity characteristics of each process / electrode combination by performing deposition rate tests.
5. Establish diffusible hydrogen characteristics for each consumable / process combination.
6. Establish preheat and/or heat input requirements to avoid hydrogen induced cold cracking with each welding process and material, using BMT's delayed cracking model.
7. Characterize and compare the cooling rates of each process on the BMT flow loop, using still air, flowing air, water-mist-spray, and flowing water to simulate a range of operating conditions.
8. Validate procedures by performing sleeve welds with mechanized equipment.

To-date, Tasks 6, 7a, and 7b have been completed with work commencing well into the fourth milestone period. At the request from industry, Task 6 was slightly modified to determine delay times of test welds most susceptible to hydrogen cracking in this program, and that the focus for preheat requirements be on preheating sleeves in accordance with industry practice. Welding has commenced into Task 7c for characterization of weld cooling rates and hardness's with each of the welding processes and flowing water conditions, for both sleeves and bead-on-pipe welding.

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